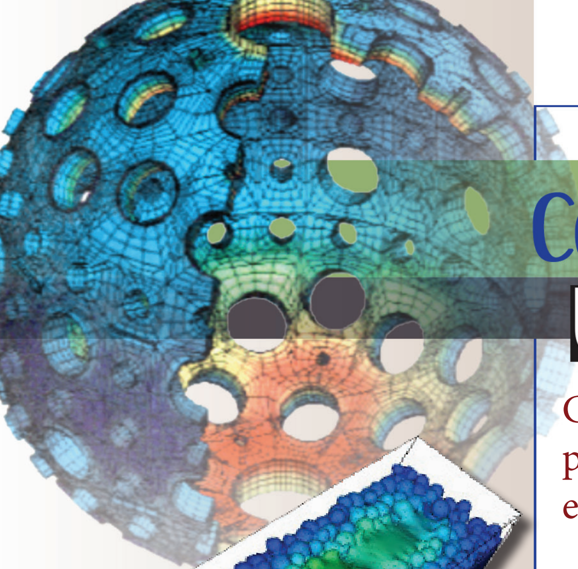
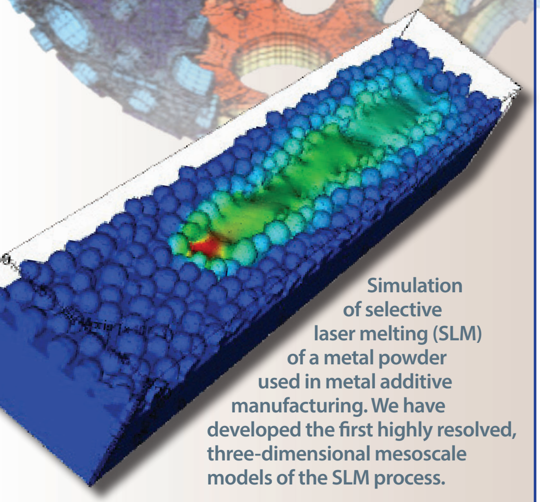


Computational Engineering

Lawrence Livermore National Laboratory

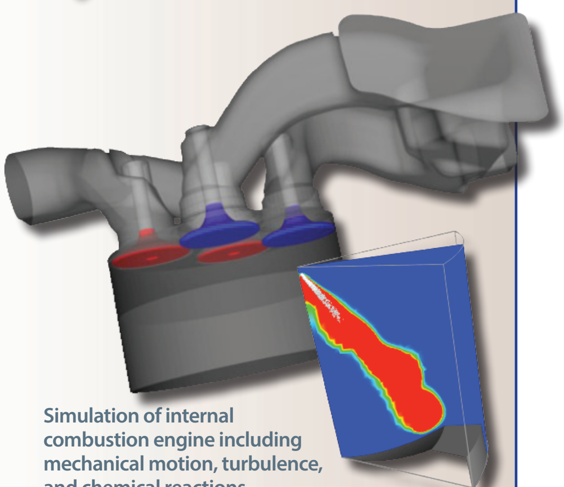


Simulation of selective laser melting (SLM) of a metal powder used in metal additive manufacturing. We have developed the first highly resolved, three-dimensional mesoscale models of the SLM process.

Computer-based simulation has become an essential tool, providing insights that often cannot be derived through experiment to inform design decisions or assess in-service assets.

At Lawrence Livermore National Laboratory (LLNL), we develop world-class simulation programs and the expert modeler/analysts who create and use them. This combination of sophisticated tools and skilled staff, supported by high-performance computing resources, provides state-of-the-art engineering solutions for our weapons, lasers, energy, and security programs.

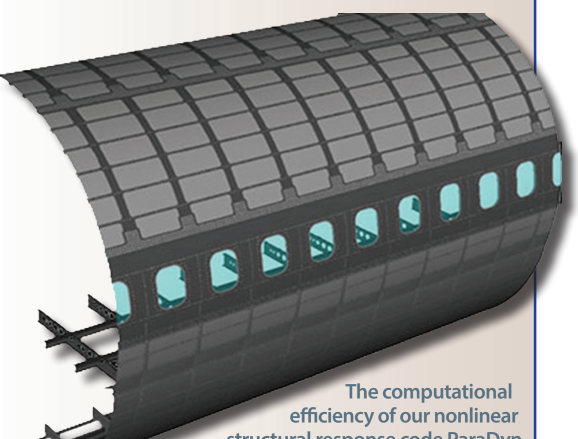
Computational engineers at Lawrence Livermore focus most of their efforts on issues related to national security. By using computational methods to perform virtual testing, they gain insight into system responses for physical environments that may be too expensive or too difficult to physically test. Virtual testing also maximizes the total knowledge gained from experimental testing. For example, Laboratory engineers apply hydrostructural analysis codes to simulate physical events that last only a few microseconds to several hundred milliseconds and involve large material deformations, high strain rates, and strong shocks. By continually developing and improving computational methods, our engineers produce reliable data that enables them to confidently evaluate and make critical decisions concerning the Laboratory's national security efforts.



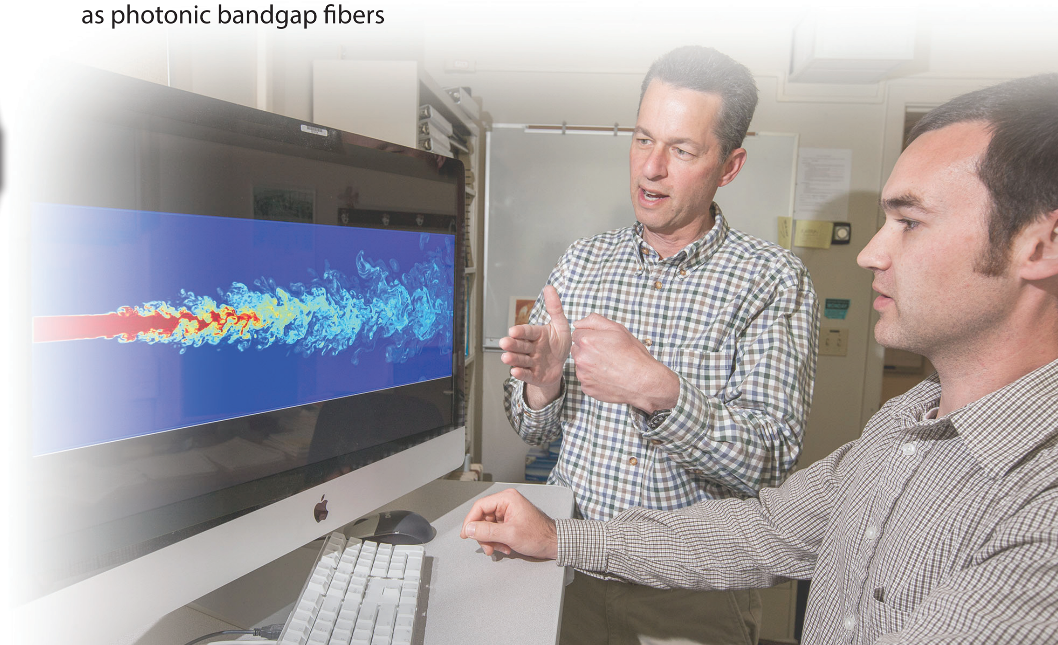
Simulation of internal combustion engine including mechanical motion, turbulence, and chemical reactions.

Example Projects

- Simulating composite assembly design, leading to first-time testing success and rapid field deployment
- Developing advanced methodologies for blast–structure interaction
- Simulating novel additive manufacturing processes
- Simulating clean and efficient combustion to inform design of next-generation engines
- Predicting wind turbine power output, including realistic weather and terrain
- Using computational techniques to optimize electromagnetic structures such as photonic bandgap fibers

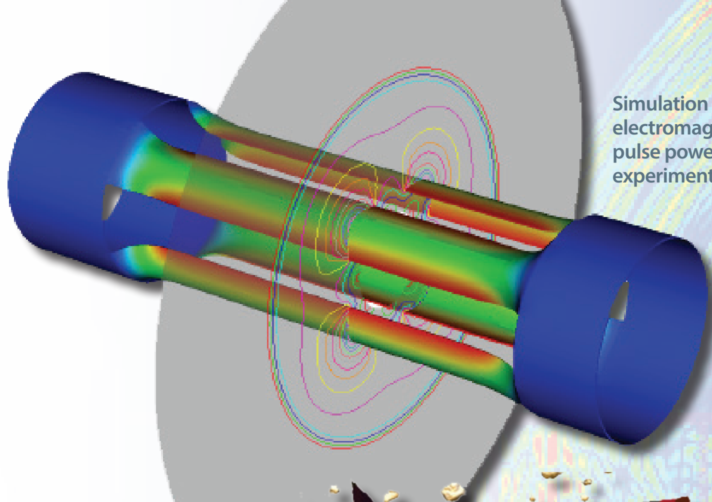


The computational efficiency of our nonlinear structural response code ParaDyn permits highly detailed modeling. The example shown includes resolution of individual rivets in the fuselage structure.



Expertise

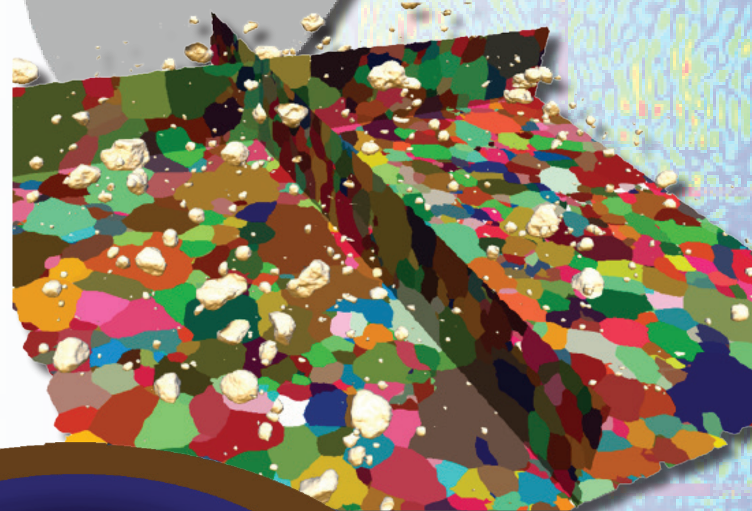
- Structural response, including to extreme load environments
- Advanced material models for metal deformation
- Full-wave, high-accuracy electromagnetics
- Fluid dynamics and turbulence modeling
- Heat transfer
- Magnetohydrodynamics
- Uncertainty quantification
- Computational optimization



Simulation of electromagnetic pulse power experiments.

Sponsors and Collaborators

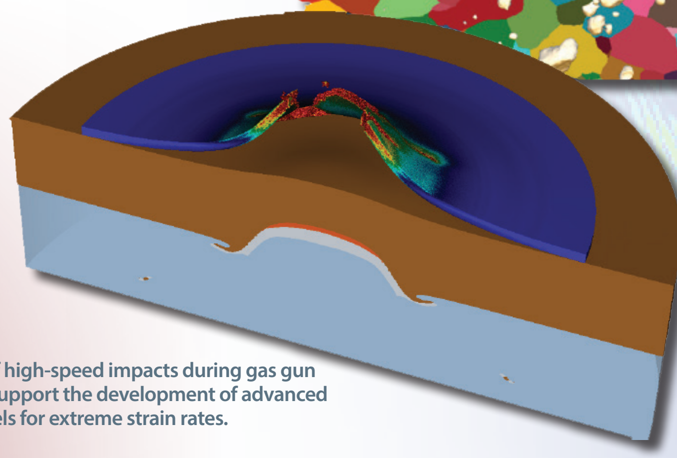
National Nuclear Security Administration
Department of Energy
Department of Defense
Department of Homeland Security
Bureau of Reclamation
Other Federal agencies
Private industry



3D imaging of the polycrystalline microstructure showing grains and voids.

Academic Alliances

Cornell University
University of California, Berkeley
University of California, Davis
Duke University
University of Illinois, Urbana-Champaign
Stanford University



Simulations of high-speed impacts during gas gun experiments support the development of advanced material models for extreme strain rates.

Capability Leaders

Dr. Robert M. Ferencz 925-422-0571 ferencz1@llnl.gov
Bob is the Director of the Center for Computational Engineering and leads the Methods Development Group team responsible for a suite of advanced, nonlinear structural mechanics codes. He has led projects to enhance and deploy MDG codes for DOD and DOE-Nuclear Energy users. He serves on the American Society of Mechanical Engineers (ASME) Standards Subcommittee on Verification & Validation for Computational Solid Mechanics. He holds a Ph.D. in Mechanical Engineering from Stanford University.

Dr. Daniel White 925-422-9870 white37@llnl.gov
Dan is the acting Division Leader of the Computational Engineering Division at LLNL. His expertise is in numerical methods for electromagnetics, parallel computing, electrical system modeling, and simulation. He obtained B.S. and M.S. degrees in Electrical Engineering, and a Ph.D. degree in Applied Science, from UC Davis.

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